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# An Intelligent Gradient Detector with Minimization of Visual Landmarks Distortion for Monitoring of Passenger Flows

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**Abstract**

In this paper, we study the problem of monitoring of passenger flows. We consider an intelligent gradient algorithm to solve the problem. We use a method of minimization of visual landmarks distortion to improve the quality of recognition.

**Mathematics Subject Classification:** 47E05

**Keywords:** technical vision, visual landmarks, distortion, energy function

The problem of monitoring of passenger flows extensively studied recently (see e.g. [1] – [3]). In particular, an intelligent gradient algorithm to solve

the problem was proposed in [3]. This algorithm uses the intelligent visual landmarks model from [1]. This model allow the algorithm re-adjust reference images. In this paper, we consider a method of minimization of visual landmarks distortion to improve the quality of recognition.

Let $V(\mathrm{Im})$ be the set of detected visual landmarks of the image Im. We can consider two consecutive images Im[1] and Im[2].

We can define each mapping from $V(\mathrm{Im}[1])$ to $V(\mathrm{Im}[2])$ as a function $F$. We can assume that

$$F(x) \in V(\mathrm{Im}[2]) \cup \{\infty\},$$

for any $x \in V(\mathrm{Im}[1])$. Also, we assume that if

$$x[1] \neq x[2],$$

then

$$F(x[1]) \neq F(x[2]).$$

Let

$$W(\mathrm{Im}[1]) \subseteq V(\mathrm{Im}[1])$$

such that $x \in W(\mathrm{Im}[1])$ if and only if $F(x) \neq \infty$.

Let $K = |W(\mathrm{Im}[1])|$. We assume that

$$W(\mathrm{Im}[1]) = \{x[1], x[2], \ldots, x[K]\}.$$

To minimize the distortion of visual landmarks in space of the image, we can minimize the following energy function [4]:

$$E = \sum_{i=1}^{K} \parallel F(x[i]) - x[i] \parallel + \lambda E_F$$

where

$$E_F = \int\int_{\mathrm{Im}} (F''_{xx} + 2F''_{xy} + F''_{yy}) dxdy,$$

$\lambda$ is the regularization parameter.

Usage of minimization of visual landmarks distortion allows us to use more similar landmarks in different positions. Let $N(m)$ be the number of visual landmarks that can be used without visual landmarks distortion for $m$ consecutive images. Let $N_d(m)$ be the number of visual landmarks that can be used with visual landmarks distortion for $m$ consecutive images. Selected experimental results are given in Tab. 1.

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| $m$ | 2 | 10 | $10^2$ | $10^3$ | $10^4$ | $10^5$ | $10^6$ |
|---|---|---|---|---|---|---|---|
| $\frac{N(m)}{N_d(m)}$ | 84 % | 82 % | 76 % | 71 % | 42 % | 12 % | 0.3 % |

Table 1: The number of visual landmarks for $m$ consecutive images.

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